
Pedagogical Exercise

A 'Keplerian' Dialogue: What Do You Know About Economics?

Part 1, by Jonathan Tennenbaum

It got around that Johannes knew something about economics. And one day Nerd, who lately had been dropping by frequently to talk to Johannes about such matters, decided to bring with him three acquaintances: Turbo—a stockbroker whom Nerd used to help with computer systems; Heavy Gripp—a former mining engineer, now unemployed, whom Nerd also used to do programming for; and Betty Gripp—Heavy's wife, who, unknown to Heavy, had invested the family savings with Turbo, into "high-tech" stocks, and lost everything. Turbo came a bit late to the meeting, after Nerd had introduced Heavy and Betty to Johannes.

Nerd: Johannes, I thought I would bring Heavy with me, since we were talking about physical economy. Heavy used to be involved in coal mining. He is very physical. I told him some of the things you were telling me, about what has really been happening to the U.S. economy. He couldn't believe it, so I asked him to come along and talk to you directly.

Heavy: (gripping Johannes's hand with crushing force) Pleased to meet you, Johannes.

Johannes: (wincing in pain) Nerd told me you were interested in real economics.

Heavy: Yes, I have always believed we had to get back to production, and stop all this speculative nonsense. I firmly believe that money is the root of all the world's problems.

Nerd: Well, speaking of money, my old friend Turbo has just arrived.

Betty: Oh my goodness! You! You scoundrel! You thief! You're the one who tricked me out of my savings!

Turbo: You gave them to me to invest for you. I can't help it if the whole market collapsed.

Heavy: Who is this, Betty?

Betty: But you told me my investments were safe!

Turbo: Mrs. Gripp, I want you to know, that your investments were placed by "PTOLEMY"—the most sophisticated computerized market analysis and projection system ever devised. PTOLEMY combines multivariate analysis, higher-order correlation functions, stochastic integrals, the Merton-Scholes partial differential equations, and advanced neural

network pattern-recognition techniques, to a data base incorporating the last 3,000 years of market developments, and updated on a nanosecond basis. Nerd here, one of the leading software specialists in the world, upgraded PTOLEMY using declassified Lawrence Livermore nuclear-explosion simulation codes, and ran the whole package on our dedicated Cray supercomputer.

Betty: But, my money is gone!

Turbo: Don't worry. The markets will go up again. They always do. You just have to wait long enough.

Betty: But I need my money *now!*

Turbo: How about a carry-over loan? Just wait a few days, I have to find a new bank to help my clients. My former banker has gone into default.

Heavy: (his huge hand gradually coming together into a fist) I don't believe *any* of that fancy talk. I think you're just a plain *thief!*

Nerd: Now, Heavy, don't talk that way to Turbo. He has five PhD degrees: mathematics, physics, economics, computer science, and Tibetan Buddhism.

Betty: (sobbing) What about *my money?*

Heavy: Betty, how could you *speculate* like that with *our* savings? I have always stuck with honest-to-God industrial stocks: GM, General Electric, Boeing, chemical companies—

Nerd: But your investments were pretty much wiped out, too, weren't they, Heavy?

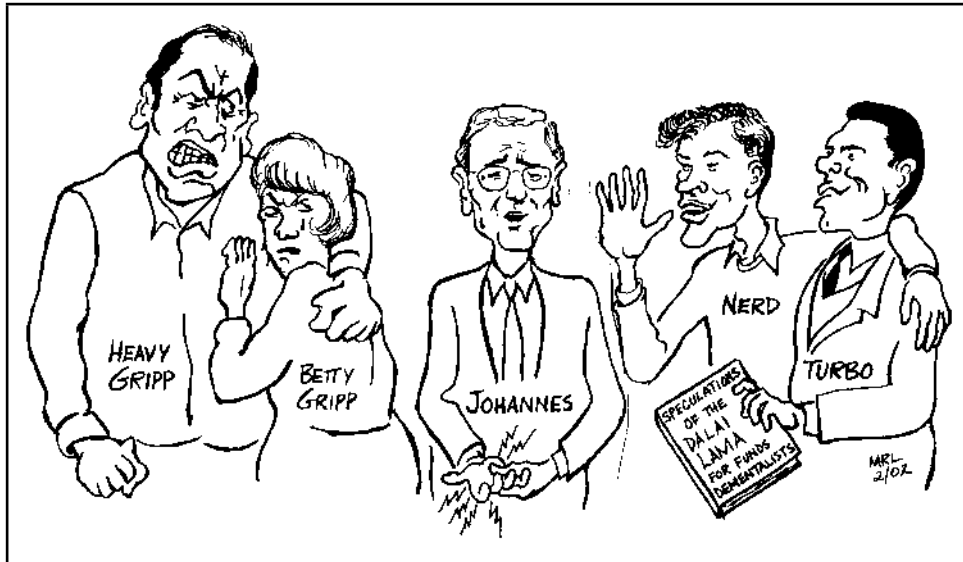
Heavy: Well, I have to admit. For some reason the profits of all those industrial companies suddenly evaporated. I can't figure it out.

To the 'Hard Data'

Johannes: Doesn't surprise me. Where should their profits come from? In net physical terms the U.S. economy has had no growth at all since the middle of the 1960s. Actually, the economy has been shrinking constantly.

Turbo: You must be crazy! U.S. real Gross Domestic Product grew three times over since the 1960s, average earnings and incomes have skyrocketed—

Johannes: Forget the GDP. It means nothing. Most of



The reason for the dramatic increases in productivity, is the revolutionary advances in the technology and methods of coal mining over the last 30 years. Now isn't that just what you call economic development—the impact of technological advance to increase the productive powers of labor?

Johannes: Wait a minute. You can never just point to a set of data like that, and say: "These data prove XYZ."

Heavy: Why not?

Johannes: Just for the same reason, that ancients like Aristarchos understood, that the true ordering of the solar

system is not the motions of the planets as they happen to appear to us in the sky. Because data, statistics, and so forth are just a kind of generalized sense perceptions. Mere sense perceptions mean nothing in and of themselves, and can never prove anything. Only hypothesis can prove something. Don't forget: In economics, we deal exclusively with Riemannian manifolds, where no scalar measurement is possible.

Heavy: Excuse me. If an average coal miner in the year 2000 produces 3.8 times more coal per year than a coal miner in the year 1973—simple arithmetic tells us that—you are going to tell me, there has been no productivity increase in the U.S. economy?! It cost me my job!

Johannes: Calm down and think about this: When we compare data from the various years, we have to take account of the change in the structure of the economy, from one period to the next, don't we? In other words, the worker was producing coal in a different economy in 2000, than he was in 1973 or 1953. So your numbers belong to different

the so-called income is just from the monetary bubble.

Heavy: But look here, Johannes, we agree there was a financial bubble. But at the same time, our agriculture and industry have grown vastly in productivity—so much so, that we don't know what to do with all the automobiles and other goods we can bring onto the market. We can put up houses and office buildings faster than ever before. We have VCRs and cell phones and many other new types of products that never existed in the past. Never before have we turned out such incredible material wealth.

Johannes: Most of the goods are inferior, cheap stuff.

Heavy: You can't say that! Cars last longer and get better mileage. PCs have increased in computing power hundreds and thousands of times, while decreasing in cost. And at same time, industrial manpower requirements have dropped precipitously. That's why I'm unemployed.

Johannes: On the contrary. The productivity of the U.S. economy has been constantly collapsing, since the mid- to late-1960s, at an accelerating rate. That is absolutely clear, if you use competent, Riemannian standards of measurement.

Heavy: Well what do you say to this: Take coal mining—an area I know first-hand. The productivity of U.S. coal mining has grown by leaps and bounds, especially in the period when you say the U.S. economy stopped developing. Productivity doubled between 1953 and 1963; grew by another third between 1963 and 1983; and then doubled again from 1983 to 1993. Since then, it grew again by another 60%. Today we have less than half as many coal miners as in the mid-'70s, but they produce almost twice as much coal. If you don't believe me, take a look at the hard facts. I have in this table (**Table 1**), figures for selected years: the number of U.S. coal miners in thousands; U.S. coal production in million tons per year; and tons of coal mined per miner per year.

TABLE 1

Heavy's 'Hard Facts' on U.S. Coal-Mining Productivity

Year	Miners (thousands)	Production (million tons/year)	Tons Mined per Miner
1953	293	457	1,559
1963	142	469	3,240
1973	148	592	3,995
1983	176	782	4,453
1993	101	945	9,331
2000	70	1,076	15,364



An investor in Boston during the stock market crash of October 1987.

geometries, and therefore you can't compare them in a simple arithmetic way.

The Question of the Whole

Heavy: I don't know what you mean. For me, a ton of coal is a ton of coal, and a worker is a worker.

Johannes: Not in their relation to the economy, and to the universe. Let's just suppose, for example, that the coal companies would throw most of the billion tons of coal the miners produce, into the sea, instead of burning it to make electricity; or suppose most of the electricity, produced from the coal, were somehow wasted. Would you say, in that case, that the economy had become more productive through the workers' producing more coal?

Heavy: Well, no. But it wouldn't be the workers' fault.

Johannes: They ought to pay attention to what is happening to the economy, that they are working so hard to supply coal for, shouldn't they?

Heavy: Your example is irrelevant. The United States burns 80% of the coal—about 850 million tons per year, to produce electricity, and that electricity is used to light our homes and offices and make our factories run. The rest is used for heating and so forth. So—apart from unavoidable losses—the coal is not wasted, and the fantastic productivity increases in coal mining are passed on to the whole economy.

Johannes: In any case you will grant, that the actual effect of the miner's producing the coal, on the economy as a whole, depends on the structure of that whole economy, not just on the amount of coal he produces?

Heavy: True.

Johannes: Also, you recognize, that the miner didn't produce the coal all by himself; he depended on a gigantic complex of machinery and infrastructure, on large inputs of energy, and so forth. All that had to be supplied. So you can't talk about the productivity of the miner, without taking into account the productivity of all the workers that supplied all the inputs he depended on, and the inputs those workers require in turn, and so on?

Heavy: But productivity has been going up in *all* branches of U.S. industry. And besides that, the cost of coal has been going down constantly—which confirms, that all in all, productivity is higher.

Johannes: But you agreed to leave monetary criteria aside, as misleading and manipulated, didn't you? Besides, weren't you a strike leader in the old days? Isn't a lot of the mining done with non-union labor nowadays?

Heavy: (red in the face) Uh, yeah . . .

Johannes: Besides that, you wanted to prove to me that productivity has increased in mining, and now you need, for your argument, the proposition that productivity has gone up in all branches of industry? Isn't that a bit circular?

Heavy: (exasperated) You just *can't* say it isn't true! Look, in the 1960s it took about 45% of the nation's employed workforce to produce the food and industrial products the nation consumed. Today it takes much less than 20% of the workforce to produce, for a level of consumption which is vastly higher than 40 years ago.

Turbo: Thanks to that, millions of lucky people were liberated from the tyranny of productive labor, to become yuppies, like me!

Johannes: Dear Heavy! You're once again arguing on the basis of mere "perceptions," which prove nothing. I shall show you in a minute, how the same "data," from which you claim to deduce vastly increased productivity, are fully consistent with a very different hypothesis, according to which the real productivity in the U.S. economy has collapsed, precipitously, over the same time interval.

Heavy: Impossible! Absurd!

What Is More Productive?

Johannes: First of all I want to get a small point out of the way. You are surely aware, that the United States has had a huge and growing trade deficit, at least until the crash began last year?

Heavy: Yeah.

Johannes: So the United States did not actually meet its own consumption, but in a sense, has been living off the rest of the world.

Turbo: That is a vast exaggeration. Last year the deficit was about \$500 billion, but the U.S. Gross Domestic Product was about \$9,000 billion. So the net of what we got from the outside is really insignificant, only about 2.5%.

Heavy: Besides, the imports are not because we can't produce for ourselves, but because foreign countries, under the pressure of overproduction everywhere, are itching to dump their goods on the U.S. market.

Johannes: Maybe the dependence is much more serious, in reality, than both of you realize. Did you know, for example, that about 38% of U.S. outlays for capital goods, are imported?

But, we agreed to leave monetary measures aside. Tell me this, Heavy. Doesn't the United States import a rather large percentage of strategic minerals—more than 99% of its consumption of asbestos, bauxite and alumina, columbium (niobium), graphite, manganese, natural mica sheet, quartz crystal, strontium, thallium, thorium and yttrium; as well as 95% of its bismuth consumption, 94% of its antimony, 86% of its tin, 83% of its platinum, 80% of its tantalum, 78% of its chrome, 76% of its titanium concentrates, and so forth? All this, in spite of the fact, that the United States has a vast and rather richly endowed territory?

Turbo: But those non-oil raw mineral imports amount to only \$3-5 billion a year, completely insignificant.

Johannes: Really? And if the supply of those minerals from abroad were suddenly interrupted, what would happen to the U.S. economy?

Heavy: We *could* produce those minerals, of course, if we wanted, on our own territory.

Johannes: Why don't we, then? Because it would be too expensive? Weren't you just telling me about the fantastic productivity of the U.S. mining sector, with its revolutionary technologies? Hasn't the government been concerned for decades about dependence on imports of strategic minerals?

Why didn't we solve that strategic vulnerability problem long ago, even if it meant spending a few billion a year?

Heavy: What are you trying to prove by all this?

Johannes: Nothing. I am just pointing out some paradoxes and anomalies, that can put us on the track of reality. But let me get back to your coal-mining sector, for a further point. Isn't it true, that over the last 30 years, the dramatic increase in tonnage produced per miner—which you choose to call "productivity"—was connected with a shift of the major source of production, from underground mines to surface (open pit) mining, mainly in the West of the United States? Didn't that greatly increase the land-use requirements per unit production, as well as nearly double the average rail transportation distance from the mine to the point of use? Isn't the surface-mined coal generally lower in heat-content density, compared to the coal accessed by underground mines?

Heavy: Yes.

Johannes: Is it not true, that surface mining became attractive, because of its amenability to automated, mass-production techniques, which process gigantic amounts of earth—as opposed to advancing the methods for pinpointing and extracting the higher-concentration deposits that exist underground? Which would require further discoveries in

Kepler's Revolutionary Discoveries

The most crippling error in mathematics, economics, and physical science today, is the hysterical refusal to acknowledge the work of Johannes Kepler, Pierre Fermat, and Gottfried Leibniz—not Newton!—in developing the calculus. This video, accessible to the layman, uses animated graphics to teach Kepler's principles of planetary motion, without resorting to mathematical formalism.



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Strip-mining of coal in Wyoming. Increased use of surface-mining methods allowed the industry to proceed at a lower overall technological mode of production.

geological science, and corresponding skills and technologies? Wasn't the apparent increase in productivity, achieved at the expense of shutting down hundreds of independent mines, discarding invaluable skills and know-how in the process; concentrating production in a few "mega" companies; laying off thousands of skilled workers and engineers, and using virtual monopoly powers to depress wages and other costs?

Heavy: Yes, that's all true; but what are you getting at?

Johannes: I am suggesting to you, once more, that despite your perception of vastly increased productivity, the United States has actually moved toward a *lower* overall technological mode of production since the mid-1960s!

Heavy: How in the world can you speak of a "lower technological mode of production"? American industry has been introducing new technologies all along. When you replace your equipment, you always try to get the most modern, state-of-the-art equipment.

Johannes: Just because a machine is new, doesn't mean it embodies a "higher technological mode of production." Quite the opposite can be the case.

Productivity and the Population

Heavy: Well, given two technological modes of production, how can I tell the higher one from the lower one?

Johannes: In principle, in two ways. First, the higher

mode is the one that incorporates one or more valid discoveries of physical principle, not embodied in the lower mode. Secondly, the higher mode of production is the one that defines the relatively higher potential population density. In other words, higher mode of production is the one, for which the maximum population, that could sustain itself on a given territory, on the basis of the given mode of production, is largest. Of course, using a higher mode of production generally requires a more developed labor force, in terms of its education and cognitive powers.

Heavy: So what are you saying?

Johannes: I am saying, that the maximum density of population, which could potentially support itself on the territory of the United States, on the basis of the *current* modes of production, employment and cognitive development of the present U.S. labor force, is actually *much lower* than the corresponding figure at the end of the 1960s! The technological trends in U.S. mining, which you describe, typify this. Land use, for example, has become more extensive, rather than intensive, consistent with a drop in potential population-density. Naturally, the potential population-density is defined by the entire range of technologies employed by society, not simply in mining.

Heavy: I still don't see it. If we can produce the same amount of wealth, with fewer workers, doesn't that mean



Apparent technological improvements in the U.S. coal-mining industry, were subsumed within a shift backward, away from the higher technological mode: nuclear energy.

greater productive power? And doesn't greater productive power mean we can maintain a larger population?

Turbo: More yuppies per productive worker!

Johannes: No. Merely *economizing labor*—as by automatized equipment, for example—in and of itself does *not* necessarily increase the potential population-density of a nation or the human species as a whole! Increase in the potential population density of the human species, is a function of the development of *human cognitive powers* to discover, assimilate, and apply new physical principles toward the mastery of the universe. The latter depends, for example, on how we develop and *employ* the labor, that might potentially be “freed up” through the use of labor-saving techniques.

Heavy: Aha!

Johannes: If we simply throw people out of productive employment, rather than upgrading their employment, and instead, transform them into parasites, then we correspondingly collapse the overall cognitive potential of society, in its per-capita power to master the universe. And that is what happened. Generally speaking, the so-called “technological development” in the United States over the last 30 years, has followed the pathway of successive adaptation to conditions of an economy characterized by declining cognitive powers of the labor force.

Heavy: I still can't believe those fantastic machines we are using in our mines today, and the sophisticated sensing, prospecting, and control instruments and techniques, that were undreamed of just 20 years ago, represent a “lower technological mode” and a lower productivity.

Johannes: We have to look at the U.S. economy as a

whole. As I told you, in a Riemannian manifold, no part has a self-evident measure; the value of any part is determined from the geometry of the whole manifold. But here is the clincher: The reason for the huge investments in scaling-up U.S. coal production, particularly since the late 1960s, is connected with the decision *not* to go for development of nuclear energy as the main technology for electricity generation, and eventually also for process heat.

Nuclear power production is characterized by a vastly higher energy flux-density than coal or other fossil energy technologies. From a pound of uranium fuel, we can produce, in a fission reactor, the heat equivalent of burning some 50,000 pounds of coal! Plus, nuclear power plants can have a much high power density than coal power plants. Nuclear power is a typical expression of the higher mode of production, toward which the United States had been shifting from the 1950s into the 1960s, but which was increasingly abandoned, in the subsequent period.

So, the apparent technological development you observed in coal mining was actually subsumed within a shift backward, from the process of moving toward a higher technological mode for the United States as a whole. The nuclear sector, which demands a much higher average educational level, a higher material living standard and health standard than coal mining, would otherwise have grown to a dominant sector of the U.S. economy, rather than merely a marginal one, as today. Taking into account things like the Moon-Mars project, fusion energy, and so forth, which would have been part of the progression to higher modes, the U.S. labor force structure would have been completely different.

Orbits of the Economy

Heavy: Well, I have to admit this sheds a completely different light on those production and productivity statistics, I was showing you. You turned everything on its head.

Johannes: As I told you, the numbers mean nothing by themselves. You have to know what geometry you are in; and here we have a *changing* geometry. For example, the U.S. economy before the mid-1960s, and the U.S. economy afterwards, embody different, axiomatically incommensurable geometrical types. These, however, cannot be deduced from the data per se, any more than astronomers could *deduce* the true orbits of the planets, and the organization of the solar system, from the apparent motions as seen from the Earth. Because in and of themselves, the apparent motions were compatible with several, mutually inconsistent interpretations—just as I have shown you for your productivity data.

Just as the planets sometimes appear to be moving in one direction, when in reality they are moving in the opposite direction, but appear to do so only because we observe them from a moving Earth; so your data give a distorted picture of reality, like all mere sense perceptions, because of the changing geometry of the whole. To discover the real ordering of changes in the economy, you need a physical hypothesis, as Kepler did for the planetary orbits; an hypothesis which cannot be deduced from perception or data more generally, but belongs to a realm beyond the discrete manifold of perception.

Nerd: You mean, we have to do, for economics, what Johannes Kepler did for astronomy?

Johannes: Exactly. It's very simple. I'll show you next time.



Part 2 to come next week.

Croatian Highway Is A Key European Project

by Our Special Correspondent

Connecting continental Croatia to its Dalmatian coast, especially the important port cities of Rijeka and Split, by modern four-lane highways, was first outlined back in 1961 by the mayor of Split. The idea was accepted by then-mayor of Zagreb Veceslav Holjevac, and the proposal was made to the Croatian communist authorities for consideration. At that time, Yugoslavia had a large, so-called Central Investment Fund. Money from that fund was mainly directed to finance development of industrial facilities, while transportation infrastructure investments were mainly directed to railroads. However, the problem was the lack of vision for the whole country, and protection of some political clientele interests in Serbia, because the Fund was controlled by the powerful Interior Minister, Aleksandar Rankovic. Therefore, authorities of the Croatian federal republic were forced to find another source to finance this large project, which was not one of Yugoslavia's development priorities.

After President Josip Broz Tito removed Rankovic and his police apparatus in 1966, some winds of freedom began to blow, and expanding space for the federal republics was created. This was the beginning of the "Croatian Spring." Already in 1968, Croatia began issuing public bonds to finance the highway project. The amount of bonds issued up till 1972 never amounted to the full investment needed, but served as an impetus to commence construction. It was hoped, that under new Constitutional amendments, the republics would gain more influence on the distribution of federal revenue, which was directed to and distributed by Belgrade.

By 1972, the first section, from the Croatian capital Zagreb, to the western city Karlovac (39 kilometers), was completed, together with 10 km of the Rijeka-Karlovac section (Rijeka is the northern-most port city of Croatia). Tito himself opened the Zagreb-Karlovac section, and allegedly asked Croatian communist leaders when they planned to complete the whole highway. But in 1972, the "Croatian Spring" was over. Its leaders, including some Croatian communists, were ousted, some of them were imprisoned, and the project was halted. However, during all of the following years, the project was always identified with the aspirations for Croatian independence.

Even though the desired Constitutional amendments were accepted in 1974 and the republics began to control most of their Gross Domestic Product, the new Croatian leadership